REMARKS

INTRODUCTION:

After the foregoing amendments and addition of new claims 24-26, claims 1-26 are pending. Claims 1, 4-6, 8, 9, 12, 15, 16, 19 and 20 are withdrawn from consideration.

Claims 2, 3, 7, 11, 13 14, 18 and 23 were rejected under 35 U.S.C. § 102(b) as being anticipated by Tepman et al. (USPN 5,879,575).

Claims 10 and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Tepman et al. (USPN 5,879,575) in view of Okumura et al (USPN 5,888,413).

Claims 21and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Tepman et al. (USPN 5,879,575) in view of Takada et al. (USPN 5,525,379).

These rejections are respectfully traversed.

In accordance with the foregoing, claims 2, 3, 10, 11, 13, 14, 17 and 21-23 have been amended and new claims 24-26 have been added. No new matter has been added.

Reconsideration is requested.

REJECTION UNDER 35 U.S.C. § 102(b):

In the Office Action, at pages 2-3, claims 2, 3, 7, 11, 13 14, 18 and 23 were rejected under 35 U.S.C. § 102(b) as being anticipated by Tepman et al. (USPN 5,879,575).

The rejection is traversed and reconsideration is requested.

It is respectfully submitted that the Tepman patent does not disclose the relatively large capacitive coupling with a reaction tube that is formed in a coil antenna in the present invention.

One feature of the present invention is a capacitive coupling segment 33. In FIGs. 2A and 2B, a capacitive coupling segment 33 is a portion that is formed in a coil 23. Although the claims are certainly not restricted to what is disclosed in the drawings, perhaps a brief review of the drawings will be useful to the Examiner. The coil 23, which acts as an RF antenna and includes windings 31 and 32, is connected to a plasma source high frequency power supply 25 and a ground. The capacitive coupling segment 33 is formed between a power supply terminal 23a that is connected to the plasma source high frequency power supply and a ground terminal 23b that is connected to the ground. When the coil 23 generates a plasma inside a reaction tube 14, the capacitive coupling segment 33 causes an ion sheath to form along the inner wall surface of the reaction tube 14. Since a relatively small amount of the plasma etching products

become attached to the inner wall of the reaction tube 14, the frequency of cleaning the reaction tube 14 may be decreased.

Thus, according to the present invention, at least the following advantages are achieved. The structure of the coil antenna 23 is non-complex. Since the capacitive coupling segment 33 is a part of the coil 23, it is not necessary to connect the coil to a separate member that acts as a capacitive coupling portion. The capacitive coupling segment 33 is easily formed by deforming the coil 23, which is not taught or suggested by Tepman et al.

Hence, it is respectfully submitted that claims 2, 3, 7, 11, 13 14, 18 and 23 are not anticipated under 35 U.S.C. § 102(b) by Tepman et al. (USPN 5,879,575). Reconsideration is respectfully requested.

REJECTION UNDER 35 U.S.C. § 103:

In the Office Action, at page 3, claims 10 and 17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Tepman et al. (USPN 5,879,575) in view of Okumura et al (USPN 5,888,413). In the Office Action at page 4, claims 21and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Tepman et al. (USPN 5,879,575) in view of Takada et al. (USPN 5,525,379).

These rejections are traversed and reconsideration is requested.

It is respectfully submitted that the Tepman et al. patent discloses in col. 7, lines 54-57, that the RF coil generates and sustains a plasma inside the reactor vessel through an inductive coupling and that the plasma may be ignited capacitively using an additional electrode. Based on the disclosure, the RF coil 150 of Tepman et al. generates the plasma only by inductively coupling and does not include a portion corresponding to the capacitive coupling segment 33. Thus, the RF coil 150 of the Tepman et al. patent is different from the claimed coil antenna of the present invention. Also, the inductive coupling of an additional electrode to produce plasma generation of Tepman et al. does not teach or suggest a plasma etching apparatus having a coil antenna that is capacitively coupled to the reaction tube. The claimed capacitive coupling may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube.

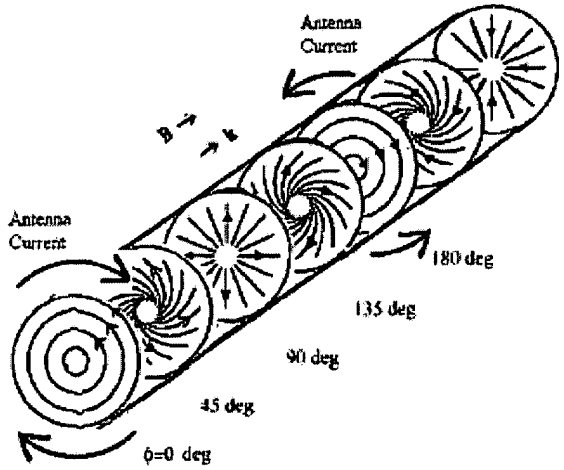
In addition, the Examiner admits in Item 2 of the Office Action that the RF coil of Tepman et al. is mounted on a coil support 270. Hence, it is apparent that the coil support 270 and the RF coil 150 are separate members, in contrast to the present invention, which utilizes a single coil to generate plasma and clean the reaction tube.

Okumura et al. teaches using a spiral discharge coil and inserting gas into a vacuum chamber to a predetermined pressure to generate plasma while controlling parameters of gas type, gas flow rate, pressure, magnitudes of high frequency power applied to the coil and the electrode and varying the high frequency power frequencies while a substrate is processed. However, Okumura et al. fails to teach or suggest a plasma etching apparatus having a coil antenna that is capacitively coupled to the reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube.

Clearly, combining Tepman et al. and Okumura et al. fails to teach or suggest a plasma etching apparatus having a coil antenna that is capacitively coupled to the reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube.

Thus, it is respectfully submitted that the present invention, a plasma etching apparatus having a coil antenna that is capacitively coupled to the reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube, is not obvious and is allowable over Tepman et al. and Okumura et al. under 35 U.S.C. § 103.

It is respectfully submitted that the Takada et al. patent (see FIG. 5a) teaches an antenna 22 that is used to generate a helicon wave plasma. A spatial distribution of an RF electric field for an m=0 (azimuthally symmetric) helicon wave propagating in an axially uniform magnetized plasma is shown below.



The peak RF current (where the phase φ =0) in the antenna loops is also shown to illustrate coupling from the antenna to the helicon wave. The ions are immobile on the RF time scale, but the electrons undergo a spacial drift so that a radial space charge is then generated in the plasma, which results in a net spiral shaped RF electric field in the plasma when the antenna current phase, φ, is between 0° and 90°. The space charge is not completely shorted out by axial parallel electron currents because of finite impedance and electron collisions. When the antenna phase reaches 90°, the RF electric field in the plasma is due entirely to the electron space charge, and thus, is purely radial (with a weak axial component). As the phase continues to increase to between 90° and 180°, the antenna current reverses direction, and thus induces an azimuthally electric field that points in the opposite direction to the field for 0° to 90°. The net RF electric field then forms a spiral which has the opposite sense as the previous spiral pattern. The helicon wave plasma generation by Takata et al. does not provide power in the same way that is recited for the present invention. Thus, Takada et al. alone, does not teach a plasma etching apparatus having a coil antenna that is capacitively coupled to the reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube.

As recited in col. 3, lines 64-67, the Tepman et al. patent teaches an RF powered coil that does not generate a helicon wave plasma and a separate moving cleaning electrode. Thus, Tepman et al., alone, does not teach or suggest a plasma etching apparatus having a coil antenna that is capacitively coupled to a reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of etching products that attach to the inner wall of the reaction tube, as is taught by the present invention.

Since the helicon wave plasma source of Takada et al. is a different power supplying means than the power supplying means utilized by Tepman et al., i.e., Tepman et al. and Takada et al. cannot be combined to provide the power supplying means of the present invention. Hence, if Tepman et al. and Takada were combined, they still do not teach a plasma etching apparatus having a coil antenna that is capacitively coupled to a reaction tube, which may cause an ion sheath to form along the inner wall surface of the reaction tube to decrease the amount of etching products that attach to the inner wall of the reaction tube, as is taught by the present invention.

Thus, it is respectfully submitted that the present invention, a plasma etching apparatus which has a coil antenna that is capacitively coupled to a reaction tube, which may cause an ion

sheath to form along the inner wall surface of the reaction tube to decrease the amount of plasma etching products that attach to the inner wall of the reaction tube, is not obvious and is allowable over Tepman et al. and Takada et al. under 35 U.S.C. § 103.

NEW CLAIM:

New claim 24 recites an inductively coupled plasma etching apparatus comprising: a cylindrical reaction tube made of a dielectric material; an antenna located around the reaction tube to generate and maintain an inductively coupled plasma inside the reaction tube, the antenna including a first winding connected to a power supply; a second winding connected at a ground; and a capacitive coupling segment continuously formed between the first winding and the second winding to produce a relatively large capacitive coupling with the reaction tube, wherein the first winding, the capacitive coupling segment and the second winding form a coil; and a drive mechanism to move at least one of the antenna and the reaction tube relative to the other to perform plasma etching.

New claim 25 recites the inductively coupled plasma etching apparatus according to claim 24, wherein the capacitive coupling segment is located closer to the reaction tube than the first winding and the second winding.

New claim 26 recites an inductively coupled plasma etching apparatus comprising a reaction tube, and a coil antenna, located around the reaction tube and having a deformed portion that, upon moving at least one of the antenna and the reaction tube relative to the other to perform plasma etching, is capacitively coupled to cause an ion sheath to form along an inner wall surface of the reaction tube to decrease attachment of plasma etching products to the inner wall surface of the reaction tube.

It is respectfully submitted that nothing in the prior art teaches or suggests the subject matter of claims 24- 26. It is submitted that these new claims distinguish over the prior art.

CONCLUSION:

In accordance with the foregoing, it is respectfully submitted that all outstanding objections and rejections have been overcome and/or rendered moot, and further, that all pending claims patentably distinguish over the prior art. Thus, there being no further outstanding objections or rejections, the application is submitted as being in condition for allowance, which action is earnestly solicited.

If the Examiner has any remaining issues to be addressed, it is believed that prosecution can be expedited by the Examiner contacting the undersigned attorney for a telephone interview to discuss resolution of such issues.

If there are any underpayments or overpayments of fees associated with the filing of this Amendment, please charge and/or credit the same to our Deposit Account No. 19-3935.

Respectfully submitted,

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